MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2017/2018

TIT3131 – INFORMATION THEORY

(All sections / Groups)

1 June 2018
3.00 pm - 5.00 pm
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 6 pages with **Five** questions only.
2. Attempt **All** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please print all your answers in the Answer Booklet provided.

QUESTION 1

(a) Refer to the problems and missing definition in **Figure 1**, write the definitions and provide the appropriate classification for theorem '***A***' and '***B***' in information theory.

Theorem	*Problem*	*Definition*
A	*What is the fundamental limit on the compression of information generated by a source?*	.....
B	*What is the fundamental limit on the transmission rate of information over a noisy communication channel?*	.....

Figure 1

[3 marks]

(b) A source emits one of the ten possible symbols from "**HELLOWORLD**". Show how to obtain the information rate of this source if one of the ten symbols is emitted, once every microsecond.

[5 marks]

(c) From the **Table 1** below, given that the Code I is **not** a prefix code and Code II is a prefix code.

i. What is the suitable value for x?

[1 mark]

ii. Illustrate the meaning of "Prefix code" using the example in **Table 1**.

[3 marks]

Symbol	Code I	Code II
A	10	0
B	11	10
C	001	110
D	x	x

Table 1

Continued...

QUESTION 2

(a) Consider a discrete memoryless source with source alphabet $\{S_0, S_1, S_2, S_3\}$ with probabilities $P_0 = 0.1$, $P_1 = 0.2$, $P_2 = 0.3$, $P_3 = 0.4$. Show that $H(S^2) = 2\ H(S)$.

[4 marks]

(b) Consider the following text fragment:

GO GOOGLE.

This text fragment contains 10 total characters (including one internal space and one dot).

i. Construct a Huffman code for the text.

[3 marks]

ii. Show the average length of the Huffman codes and the efficiency of the code.

[3 marks]

Property 1:	$I(A_X,A_Y) = I(A_Y, A_X)$
Property 2:	$I(A_X; A_Y) < 0$
Property 3:	$I(A_X; A_Y) = H(A_X) + H(A_Y)$

Table 2

(c) Modify the properties of mutual information in **Table 2** above if they are **not** correct.

[2 marks]

Continued...

QUESTION 3

(a) A source X produces letters from a two symbol alphabet with the probability assignment $P_x(0) = 0.8$ and $P_x(1) = 0.2$. Each source letter x is transmitted through a channel as shown in Figure 2 and the transition probabilities indicated below.

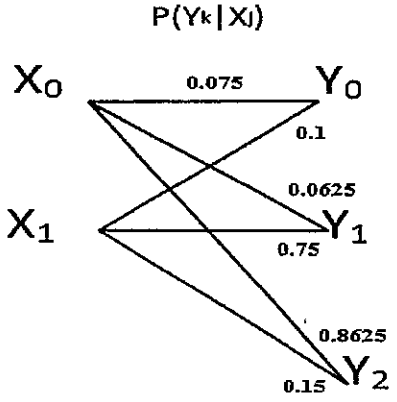

Figure 2

i. From **Figure 2**, prepare the conditional probability $P(y|x)$ and joint probability tables $P(y, x)$.

[4 marks]

ii. Write all the steps to show that $I(Y, X)$ equal to $I(X, Y)$.

[5 marks]

(b) A particular channel is described by a channel matrix with only one non-zero element in each column. Illustrate the corresponding channel matrix and channel diagram using suitable example and classify the name of this channel.

[3 marks]

Continued...

QUESTION 4

Consider the generator polynomial for a (8, 4) cyclic code generated by

$$g(D) = 1 + D^2 + D^4$$

(a) Construct the generator matrix, G in "**systematic**" form.

[4 marks]

(b) Construct all the valid code words for the following messages in "**non-systematic**" form. Show your steps.

Message	m(D)	c(D)	Code word
0111			
1000			
1001			
1010			

[4 marks]

(c) Construct all the valid code words for the following messages in "**systematic**" form. Show your steps.

Message	m(D)	c(D)	Code word
0111			
1000			
1001			
1010			

[4 marks]

Continued...

QUESTION 5

Given convolutional code of path 1 and path 2 as follows:

$$g_1 = [1,1,1],$$
$$g_2 = [0,1,1]$$

(a) Illustrate the convolutional encoder corresponding to the codes.

[4 marks]

(b) Construct the code tree for this encoder with depth of 4 branches.

[3 marks]

(c) Trace the path of the code tree from **Question 5(b)** corresponds to the message sequence 1100 and show the output sequence.

[2 marks]

(d) Illustrate the state diagram of the code.

[3 marks]

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